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(54) A communication system

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Specification

1. Name of the invention
A communication system
2. Scope of claims of patent
In connection with a radio system using a 16 quadruature amplitude modulation method, a communication system characterized by: having radio equipment of a 4 Phase Shift Keying Method that uses a reserve channel[s]; if there is trouble with a currently used line on a channel for currently used lines, dividing into two, input signals from path 1 and path 2 to be inputted to the radio equipment that uses the channel having trouble; inputting [the divided signals] to the said radio equipment for the currently used channel and to the radio equipment of a 4 Phase Shift Keying Method that uses the said reserve channel[s] or to radio equipment of a 4 Phase Shift Keying Method that uses two reserve channels; and transmitting in parallel the said signals from path 1 and path 2 by a 4 Phase Shift Keying Method.
3. Detailed description of the invention
(a) Technical field of the invention
The present invention relates to a communication system using a 16-value quadruature amplitude modulation (hereinafter called 16QAM) method and to a communication system that can be configured at a low cost.
(b) Background of technology

Figure 1 is a layout of signal points, and (A) is a case of a 4-phase phase shift keying modulation (hereinafter called 4PSK) method and (B), a case of 16QAM; and a symbol "○" in the figure indicates a signal point.

As is shown clearly by a comparison between (A) and (B) in Figure 1, spacing between signal points is narrower in the case of a 16QAM method than in the case of a 4PSK method. For this reason, it is known that [a 16QAM method] is more vulnerable than [a 4PSK method] with respect to a required carrier wave/noise (hereinafter called C/N) by approximately 7db and by approximately 10db with respect to waveform distortion.

Also, a 16QAM method can be considered to be a modulation method with overlapping layers of two PSK signals in so-called path 1 and path 2. Accordingly, in transmitting a four-bit signal at the same time, if [the four-bit signal] is divided into two-bit signals ~~each~~ *each* in path 1 and path 2 and transmitted in parallel using a 4PSK method by two pieces of radio equipment of either a 16QAM or 4PSK method; and then these are received by receivers of respectively a 16QAM method or a 4PSK method, and synthesized into signals of two bits ~~each~~ *each*. Thus, a four-bit signal can be received at the same time.

Figure 2 shows a frequency layout (A) and differential fading (B) of channel rows in a microwave band.

As shown in Figure 2 (B), there is a differential fading phenomenon in a microwave band in which spatial propagation loss becomes greater only in a certain

frequency band. For this reason, certain channels are kept as reserve channels and when differential fading arises, a line in which it arose is switched to a reserve channel. Also, as explained earlier, since the 16QAM method is more vulnerable than the 4PSK method with respect to C/N by about 7db and with respect to waveform distortion by about 10db, [the conventional technology] uses a space diversity method, and has such things as an amplitude equalizer in every channel to deal with fading and a transversal equalizer to reduce interference with encoding. The present invention makes a cost of a radio system less expensive by using a single antenna system and by eliminating need for an amplitude equalizer and a transversal equalizer.

(c) Conventional technology and problems

Figure 3 is a block diagram of the transmission side of a radio system in an embodiment of the conventional technology, and Figure 4 is a block diagram of the reception side of a radio system in an embodiment of the conventional technology.

In the figures, 1-1 ~1-3 are modulators; 3-1 ~3-3, wave divider [wave splitter?]; 4-1, 5-1, [and] 5-2, antennae; 6-1-1 ~6-3-1, [and] 6-1-2 ~6-3-2, receivers; 7-1 ~7-3, SD (space diversity) synthesizer; 8-1 ~8-3, amplitude equalizers; 9-1 ~9-3, demodulators; [and] 10-1 ~10-3, transversal equalizers.

Now, the following explanation assumes that on the *side* transmission side, the ~~side~~ of modulators 1-1 and 1-2 is *side* for currently used lines and the ~~side~~ of 1-3 is for reserve; and on the reception side, the side of receivers 6-1-1, 6-1-2 and 6-2-1, 6-2-2 is for currently used lines; and the side of 6-3-1 and 6-3-2 is for reserve.

As shown in Figure 3, the transmission side modulates 4-bit signals from path 1 and path 2 by the modulators 1-1 and 1-2 using a 16QAM method, and transmits [the signals] via wave dividers [or splitters] 3-1 and 3-2, respectively via two transmitters 2-1 and 2-2 and the antenna 4-1. If there is trouble with a line in any channel due to such causes as occurrence of differential fading, input to path 1 and path 2 of the channel in which the trouble occurred is switched to the reserve side, and transmitted via the modulator 1-3, transmitter 2-3, wave divider [or splitter] 3-3 and antenna 4-1.

On the reception side, as shown in Figure 4, [signals] are received via diversity antennae 5-1 and 5-2, ordinarily separately per channel by the receivers 6-1-1, 6-1-2, 6-2-1 and 6-2-2; synthesized by SD synthesizers 7-1 and 7-2; with [their] amplitude amplified by the amplitude equalizers 8-1 and 8-2; demodulated by the demodulators 9-1 and 9-2; equalized by the transversal equalizers 10-1 and 10-2; and outputted per channel as 4-bit signals. If a certain channel on the transmission side is switched to the reserve side, signals transmitted via the transmitter 3-3 in Figure 3 are received via the antennae 5-1 and 5-2, receivers 6-3-1 and 6-3-2, synthesizer 7-3, amplitude equalizer 8-3, demodulator 9-3, and transversal equalizer 10-3, and four bits outputted from the channel that was switched to the reserve side are transmitted to the terminal side to which it was switched. In this conventional system, however, generally due to a diversity system, two sets of receiving antennae and receivers per channel are needed; and a synthesizer is needed as well; and an amplitude equalizer and transversal equalizer are needed for improvement on C/N and as reinforcement against waveform distortion. As a result, there is a drawback in that [the system] becomes expensive.

(d) Purpose of the invention

The purpose of the present invention is, by eliminating the above-stated drawback, to provide a communication system that can comprise a radio system of a 16QAM method at a low cost.

(e) Configuration of the invention

In order to accomplish the above-stated purpose, the present invention is characterized by: having radio equipment of a 4 Phase Shift Keying Method that uses a reserve channel[s]; if there is trouble, due to a cause such as fading, with a currently used line on a channel for currently used lines, dividing into two, input signals from path 1 and path 2 to be inputted to the radio equipment that uses the channel having trouble; inputting [the divided signals] to the said radio equipment for the currently used channel and to the radio equipment of a 4 Phase Shift Keying Method that uses the said reserve channel[s] or to radio equipment of a 4 Phase Shift Keying Method that uses two reserve channels; and transmitting in parallel the said signals from path 1 and path 2 by a 4 Phase Shift Keying Method; and having a one-antenna system and having no need for an amplitude equalizer or transversal equalizer.

(f) Embodiment of the invention

An embodiment in accordance with the present invention is explained following the figures as follows. Figure 5 is a block diagram of the transmission side of a radio system which is an embodiment in accordance with the present invention, and Figure 6 is a block diagram of the reception side of a radio system which is an embodiment in accordance with the present invention.

In the figure, 11-1 and 11-2 are radio equipment of a 16QAM method for currently used channels;

12-1 and 12-2, radio equipment of a 4PSK method for reserve channels; 13 and 14, antennae; 15-1 and 15-2, radio equipment of a 16QAM method for currently used channels; and 16-1 and 16-2, radio equipment of a 4PSK method for reserve channels. A transmitter of each piece of the above-stated radio equipment has a wave divider [or splitter] at its back-end as in the case of an embodiment of the conventional technology in Figure 3.

Figure 5 and Figure 6 use one-antenna system, and the reception side of each piece of radio equipment is not equipped with an amplitude equalizer or a transversal equalizer.

In an ordinary case, a four-bit signal transmitted from path 1 and path 2 of each channel is inputted to radio equipment of a 16QAM method, 11-1 and 11-2, and transmitted to the other side via an antenna 13. On the reception side, it is received via an antenna 14 by radio equipment of a 16QAM method, 15-1 and 15-2, and a four-bit signal that was transmitted is restored. If there arise trouble with a line on any one of the currently used channels due to such cause as differential fading, lines are switched so that input from path 1 into the channel, of which line failed, may be inputted in parallel to radio equipment of a 4PSK method, 12-2, for a reserve channel and that input from path 2 may be inputted in parallel to radio equipment of a 4PSK method, 12-1, for a reserve channel;

or for example, if a line trouble occurs with a channel for the radio equipment 11-1, then, of [signals from] path 1 and path 2 to be inputted to the radio equipment 11-1, for example, path 2 is switched to the radio equipment 12-1, and the modulation method for the radio equipment 11-1 is changed from a 16QAM method to a 4PSK method; and the radio equipment 11-1, together with the radio equipment 12-1 of a 4PSK method, transmit signals from path 1 and path 2 in parallel. As to whether one or two reserve channels are to be used, above, the selection can be made depending on a degree of the fading or whether the trouble is due to some equipment failure.

On the reception side, if transmission is made using two reserve channels, radio equipment of a 4PSK method, 16-1 and 16-2 receive the transmission, and each of the outputting lines is switched with outputting lines of radio equipment for the currently used lines, for example, radio equipment, 15-1, so that 4-bit signals can be transmitted to the terminal side. If one reserve line channel is used, and for example, radio equipment 11-1 of a 16QAM method and radio equipment 12-1 of a 4PSK method make transmissions in parallel both using a 4PSK method, a signal line of path 2 of the radio equipment 15-1 of a 16QAM method is switched with an output line from the radio equipment 16-1 of a 4PSK method, and signals from path 1 outputted from the radio equipment 15-1 and from

path 2 outputted from the radio equipment 16-1 can be used so that 4-bit signals can be transmitted to a terminal. As described above, in the case of line trouble, transmission is made using the 4PSK method which withstands C/N and waveform distortion, and there is a benefit to the system by way of improvement by about 17db; so one-antenna system will do for both transmission and reception; as for transmitters and receivers shown in Figures 3 and 4, only one each per channel is necessary; a wave divider [or splitter], a synthesizer, an amplitude equalizer or a transversal equalizer is not necessary; consequently, even if two pieces of radio equipment of a 4PSK method are used, the cost will be far less. Incidentally, in the above-stated embodiment, a case in which two channels of currently used lines are used is described, but the more channels there are for the currently used line, the greater the effect of cost reduction will be.

(g) Effect of the invention

As explained in detail above, in accordance with the present invention, one antenna system will do, and no longer will two sets of transmitters and receivers be needed as in the case of a diversity [system]; in addition, an amplitude equalizer or transversal equalizer will not be needed, either; accordingly, [the present invention] has an effect of reducing the cost of a radio system of a 16QAM method.

4. Simple explanation of figures

Figure 1 is a layout of signal points; Figure 2, a drawing showing a relationship between a frequency layout per channel in a microwave band and differential fading; Figure 3, a block diagram of the transmission side of a radio system which is a conventional embodiment; Figure 4, a block diagram of the reception side of a radio system which is a conventional embodiment; Figure 5, a block diagram of the transmission side of a radio system which is an embodiment in accordance with the present invention; and Figure 6, a block diagram of the reception side of a radio system which is an embodiment in accordance with the present invention.

In the figures, 1-1 ~1-3 are modulators; 2-1 ~2-3, transmitters; 3-1 ~3-3, wave dividers [or splitters]; 4-1, 5-1, 5-2, 13, [and] 14, antennae; 6-1-1 ~6-3-1, 6-1-2 ~6-3-2, receivers; 7-1 ~7-3, SD Synthesizers; 9-1 ~9-3, demodulators; 10-1 ~10-3, transversal equalizers; 11-1, 11-2, 15-1, [and] 15-2, radio equipment of a 16QAM method; [and] 12-1, 12-2, 16-1, 16-2, radio equipment of a 4PSK method.

Agent Patent Agent Koshiro Matsuoka [*Seal of Patent Agent, Koshiro Matsuoka*]

Figure 1

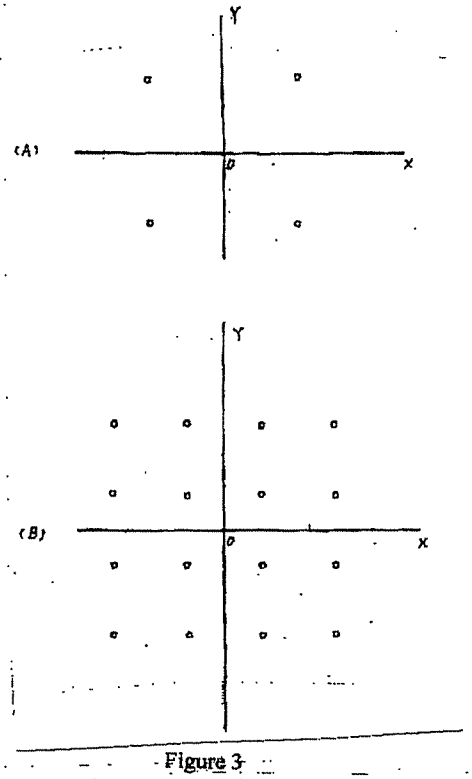

Figure 2

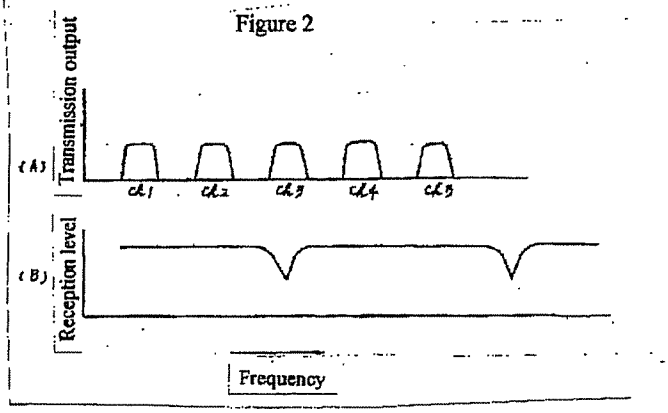

Figure 3

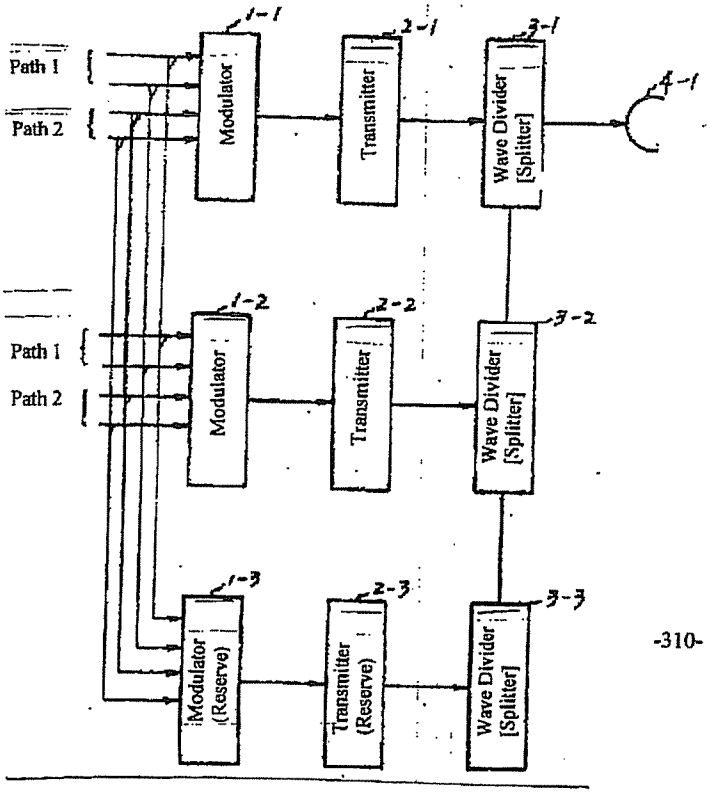

Figure 4

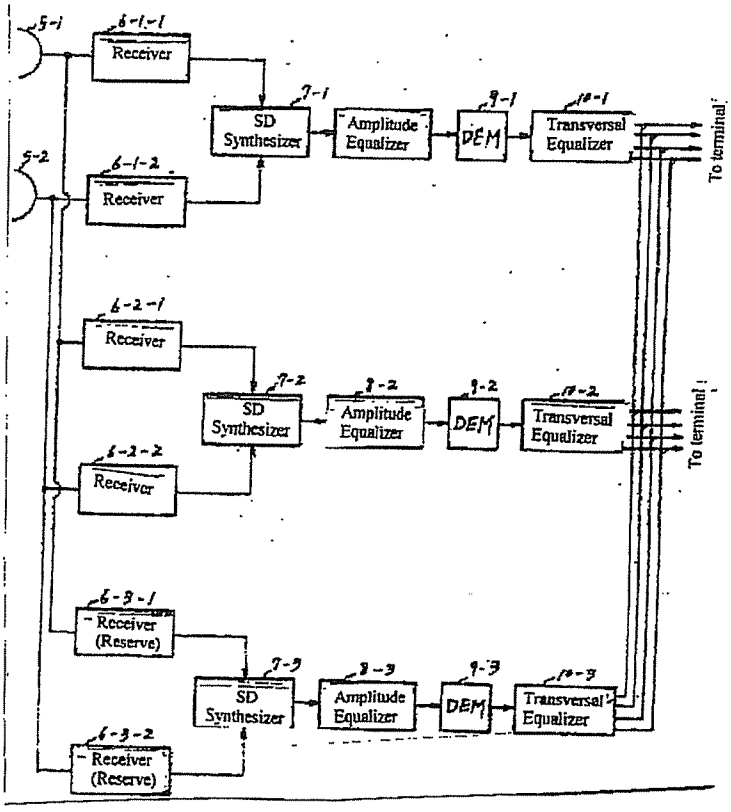

Figure 5

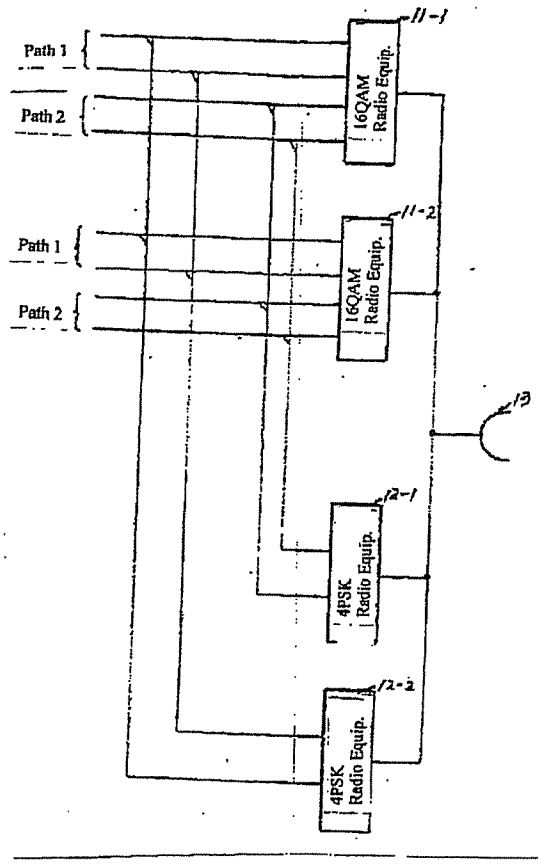

Figure 6